of. Investigation of rates and temperature coefficients.

The Zenith Telescope. Investigation of constants. Determination of latitude.

The Universal Instrument. Refined determination of azimuth. Latitude from altitudes of stars. Time from transits over the vertical circle of Polaris, Doellen's method.

Transit Instrument in the Prime Vertical. Determination of latitude and declinations of stars.

The prosecution of such a course of study necessarily implies a considerable addition to the student's theoretical knowledge, and concurrently with his instrumental work he should take up in the standard treatises such subjects as precession, nutation, aberration, refraction, the reduction of star places, etc.; but we here approach, if indeed we have not already passed, the bounds which separate engineering study from the domain of the professional astronomer.

The points at which the writer of this paper seeks to place special stress are that a brief course in spherical and practical astronomy is properly a part of the professional training of every engineer in whose work surveying is to occupy an important place, and that this instruction can be advantageously given with no further instrumental equipment than that possessed by every good school of engineering.

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HOW FAR SHALL THE PERIODIC LAW BE FOLLOWED IN TEACHING CHEMISTRY?

More than a quarter of a century has passed since Mendeleeff announced the Periodic Law. Any one who critically surveys this period will be forced to admit that this discovery has been the most fruitful of results of any since the Atomic Theory, and I believe we are just beginning to realize the value of this Natural Law and to have some idea of the fulness of its true meaning.

Chemists have shown themselves very conservative in the adoption of such discoveries and the ordering of their science by means of them, but it seems that in this case they have carried their conservatism too far. And perhaps this conservatism has not always been that which springs from a careful guarding against the possibly false and misleading, but rather from mental inertia and a dislike of giving up the old and learning the new.

The Natural Law, if true, introduces some most radical changes into the science. It is in a measure subversive of the old. It is impossible to cling to the old system while ascribing high praise to the Periodic Law, as is done in so many of our text-books.

If this law is true it must dominate all of chemistry. Its statements are fundamental and all-embracing. It cannot consent to share its authority with the old system. There can be no half-way measures. Just in so far as it is accepted as proved it must be incorporated into the science. The custom has been to teach chemistry to beginners very much in the old style, and then to give a short time to explaining the Periodic Law, instead of teaching the science with this as the very foundation.

It is manifestly the duty of a conscientious teacher to satisfy himself as to how far this law is true, and then to make all possible use of it in his teaching, as he does of the Atomic Theory itself. If it is false reject it, if true let it be the foundation of your system of instruction.

Now let me say, at the beginning, that for myself, I regard this law as incomplete in several of its details. But some points of prime importance may be regarded as settled.

1. That the elements are not distinct and separate individuals, but are more or less

closely related and must be treated in some measure as we treat the hydrocarbons. The degree and nature of the relationship is as yet unkown.

This idea of the inter-relationship of the elements must be at the bottom of all teaching of the science. I do not think it possible in the present state of our knowledge to lay very much stress upon that which is called periodicity, nor yet upon the degree of relationship as expressed by the atomic weight differences.

If too much stress is laid upon them in their incomplete state they may bring into doubt the great truths of the law.

2. The old division into metals and non-metals, or metalloids, is no longer permissible. It was always most arbitrary and indefensible, except on the grounds of convenience. It is no longer convenient, and being a false distinction it serves only to obscure the truth. I think some of the hesitation in accepting the Periodic Law has been due to the false ideas springing from this old-time division.

There is no such clear-cut division between the elements.

It would be contrary to the fundamental idea of their kinship. They must be taught by groups and the gradation of positive to negative tendencies pointed out along with the change of atomic weight and of valence.

3. It is clear that, if these elements are related and show a certain gradation in properties and the old idea of their separate and distinct individuality is to be given up, then the proper classification for the salts is under the head of the acid which mainly determines their nature and not, as in the old way of teaching, under the head of each metal. Mineralogists long ago seized upon this as the simplest and most natural way of classifying minerals, but chemists have been slow to catch the idea. I can assure my fellow teachers, from my own experience, that time is saved, the subject made clearer and the tax upon the memory lessened by this simple change of classification.

4. Valence and the gradations in it must be taught according to the natural arrangement. We cannot stand back because confronted with something which we cannot explain. Many of the facts of the science must be taught as facts leaving the explanation to those who are to follow us and to whom many of the things which are mysteries to us will be made plain.

It is just as well for the chemist of to-day to acknowledge that with all of the progress, of which he is justly proud, he is really only on the threshold of his science and that he is surrounded by the unknown on every side. What does he know of chemical force itself, of the nature of the atoms, of the character of this wonderful relationship, of valence and of many other problems?

I do not think the beginner should be tried too much with discussions of these problems nor with attempted explanations.

Such explanations are too subject to change. As to periodicity, I question the advisability of laying too much stress upon this feature of the Mendeleeff System in teaching Elementary Chemistry. It is true that the author makes this the first one of the eight conclusions drawn from his System but he speaks of it as an 'evident periodicity.' Every chemist who has examined into the matter will admit evidences of periodicity, but as the periods are irregular and not fully agreed upon, as the character of the periodicity varies and is unexplained, it is not wise, I repeat, to lay too much stress upon this feature yet awhile. The recurrence of elements of the same properties, that is periodicity, must be mentioned, but I would prefer to impress all this in a general way as a dependence of the properties upon the atomic weights. Still, I think, this is largely a personal matter. I do not like to teach with too

much dogmatism to young students half-discovered truths.

5. The system gives us certain typical elements. From these can be deduced the properties for the various members of the groups, and their treatment is greatly simplified. The old division into families, which was partial only, is broadened and filled out in the new groups.

6. I freely acknowledge that there are difficulties to be met. How could we expect it to be all plain sailing where our knowledge is so incomplete and that which we suppose we know is often so inaccurate. It is sometimes difficult to assign an element to its proper group and one is especially troubled by what Blanshard has called 'Cross-Analogies.'

I believe the atomic weight is to be accepted as the final arbiter of arrangement in all cases.

I have prepared a table in which what I have regarded as the most prominent facts of the Natural System are presented.

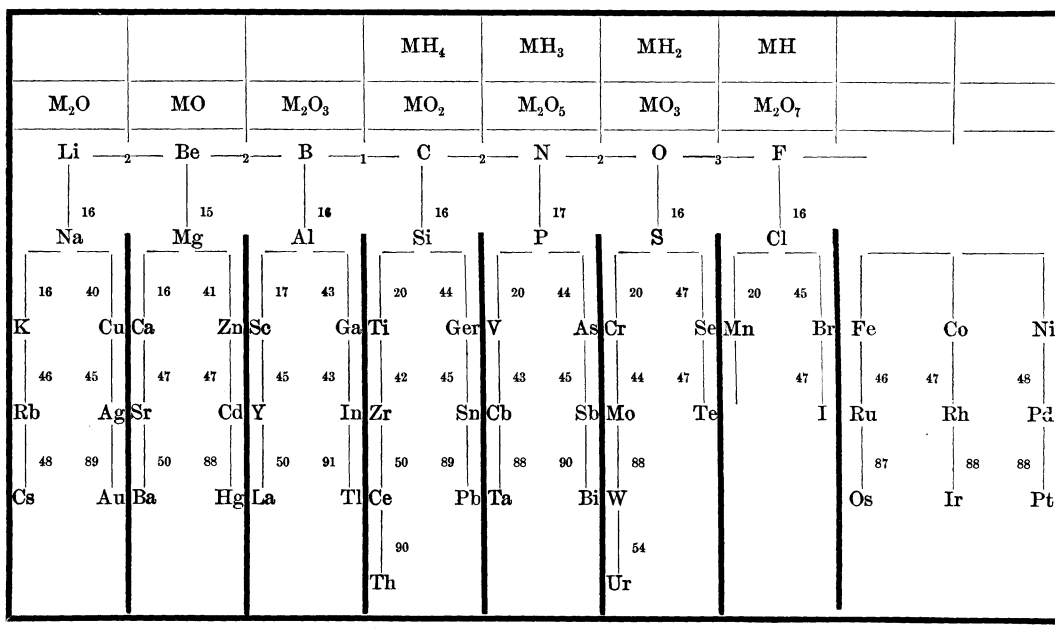
I offer this only as possessing the value of success under personal trial.

I do not propose it as something free from objections, but merely as the best that I have been able to think out. I hope to improve it on further trial, and I trust that others will see and suggest improvements. The table was printed in the American Chemical Society's Journal for January, 1895.

My method, following Lothar Meyer's notable lecture before the German Chemical Society, is to preface the course with a discussion of water as a compound, air as a mixture, and the component elements. This gives the three classes of elements, compounds and mixtures, and some opportunity for fundamental laws. Then the table is given and its working explained.

All of the elements are then described in their proper order.

Then their hydrogen compounds, followed by the oxygen compounds. As each acid-forming oxide is reached, its salts with all the bases are given and described.



The system is simpler, clearer, saves repetition and time (five months instead of six and a half), is less burdensome to the memory, and gives a fairly uniform system for inorganic and organic chemistry. This in itself is an advantage not to be lightly estimated.

The table is not to be pushed too far—one must be careful not to go to lengths incapable of direct proof. The position in which the elements fall should not be used as having any reference to their genesis, derivation or composition.

As to graphic representations of the Natural System, I have examined all and rejected all as unsuited to teaching the science. All are open to the serious objection of carrying analogies too far, and leading the student on to deductions and dreams for which the chemist of to-day has no possible proof.

Take for example the pendulum oscillations of Spring and Reynolds, inseparably connected now with Crookes' speculation as to the Genesis of the Elements or take Preyer's condensation-steps and generation pyramids, all full of this idea of the genesis. Mendeleeff dismisses the idea of such curves of properties as Meyer devised, and there is much weight in his criticisms. Such curves are, at any rate, instructive only to those who are capable of reading mathematics critically.

I would counsel the use of the simple table without the questionable aid of curves or diagrams of any kind.

The summing up of the whole matter is this: If the Natural System is true it cannot be relegated to a side place in your teaching. It forms the basis of your entire course, and unless you utilize it you are occupying a false possition and depriving yourself of the most valuable aid which the teacher of to-day has at his command.

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THE STATUS OF THE SOLAR MAGNETIC PROBLEM.

A SERIES of papers has been published in different journals during the past four years giving a very brief account of the steps taken in the investigation of the general problem of the transference of energy from the Sun to the Earth. It is probable that the main thread of the argument may be obscure to some readers for want of a consecutive statement of the case, and it is therefore proposed to summarize the evidence already obtained, as well as to indicate the nature of the scientific questions immediately at hand.

The research has been one of peculiar difficulty to successfully prosecute to definite conclusions, not because the line of operations was obscure, nor on account of the intricate mathematical conditions, but chiefly in consequence of the looseness of the phenomenon under consideration. By looseness is meant the wide deviations from the normal laws, whatever these may be, arising from the actual spasmodic actions of the sun on the one hand, and the very indirect effect of the solar energy thus generated upon the terrestrial, magnetic and meteorological fields, as recorded by the instruments employed in observations. This is an ordinary difficulty when the ether is the medium of the transference of energy between masses of matter widely separated in space, and in our case it is especially complex by reason of the complicated nature of the transmitter and the receiver, namely, the sun and the earth respectively. The solution of the problem must necessarily be by a system of approximations, in which unknown terms are carried hidden in the residuals during one operation, until the result obtained enables a repetition of the work under clearer conceptions. Also the complication of terms is so great that it is only by the successful treatment of an enormous mass of material that the im-